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NOTA DI LAVORO 52.2005

APRIL 2005

CCMP – Climate Change Modelling and Policy

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Multilateral Environmental Agreements and Trade Obligations: A Theoretical Analysis of the Doha Proposal

Summary

The Doha declaration on trade and environment proposed to clarify the relationship between multilateral environmental agreement (MEA) trade obligations and WTO rules by only guaranteeing economic integration upon ratification of certain MEAs. In other words, it pushed to authorize the use of trade measures against non-compliance, denying a non-signatory of its WTO rights to exercise countervailing tariffs. This paper demonstrates that the Doha proposal can be effective when environmental policy and its trade obligations are endogenous. Under plausible circumstances, ratification by a non-signatory to the MEA along with free trade as a reward is the unique equilibrium outcome. Delocation to pollution havens does not occur, as optimal tariffs are positive if standards are not adopted. Tariffs however only work as a credible threat and do not emerge in equilibrium. Results are consistent with broad empirical evidence that opposes the pollution haven hypothesis and suggests capital movements to be non-pollution related.

Keywords: Environmental policy, WTO, Location of firms, Green tariffs, Multilateral environmental agreements, Doha declaration

JEL Classification: F13, F18, F23, H23, Q56, R38

I am grateful for invaluable comments and extensive guidance and support by Peter Neary while working on this paper. I would also like to thank Richard Baldwin, Scott Barrett, Erwin Bulte, Dermot Leahy, Kresimir Zigic and the participants of the ZEW workshop in Mannheim on the management of global commons (June 2004) for helpful comments. Financial support from the Institute for the Study of Social Change at University College Dublin is acknowledged.

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1. Introduction

The link between trade liberalization and environmental protection is increasingly gaining importance with the latter constituting a bigger part of WTO rounds in recent years.[1] The primary debate led by environmentalists is that trade liberalization damages the environment. One argument has been that in the absence of trade policy instruments, governments may be tempted to distort their environmental policies to protect their domestic economy. If allowed, they can impose a loose regime of environmental regulation for fear that tougher environmental policies may damage the competitiveness of their firms.[2] Such policies may also cause domestic firms to relocate plants abroad to pollution havens, mainly developing countries (South), or close down altogether in response to foreign competition that faces less strict environmental regulation and hence lower production costs.

When it comes to enforcing environmental standards on a global level, the South has shown to be lagging behind regardless of rising international concern over the environment. While intellectual property rights have officially found their way onto the WTO agenda through the TRIPS agreement and labor standards have failed to make a convincing case for inclusion, environmental protection remains in a limbo state. The notion of enforcing environmental standards globally through the WTO is however moving closer to realization with the latter devoting greater attention to environmental negotiations in recent rounds. A significant part of the Doha declaration in 2001 for instance dealt with trade and environment.[3] In fact, there are about 200 multilateral environmental agreements (MEA) in place today, of which

[1] For a survey of traditional and strategic literature on environment and trade see Neary (2000).

[2] Barrett (1994) for instance shows that in imperfectly competitive international markets, governments may be tempted to impose a weak environmental policy where the marginal cost of abatement is less than the marginal damage from pollution.

[3] Neary (2004) addresses and analyzes the key issues of the Doha development agenda and obstacles that must be overcome for successful negotiations in future rounds of the WTO.

only 20 contain trade provisions.[4] Loopholes currently allow non-signatories to use their WTO rights to protest trade restrictions put against them by a MEA. This has lead to suggestions to eliminate such free riding opportunities by only allowing WTO members that are also parties to a MEA to practice their WTO rights. As a first step, ministers have agreed in the new Article 31 (i) of the Doha text to launch negotiations on the relationship between existing WTO rules and specific trade obligations set out in MEAs.[5] WTO in this case could give a signatory country the choice to only accept greater economic integration with another country if the latter agrees to ratify and adopt stronger environmental standards. In other words, it allows rivals of a non-signatory country to impose punishing tariffs on its imports for having laxer environmental regulations in the case of non-compliance (http://www.wto.org/english/thewto_e/minist_e/ min01_e/mindecl_e.htm).[6] Can such tariffs be justified, and if so, what is their impact on the location of firms and environmental policies in the South?

Theoretical literature on environmental policy and the location of firms goes as far back as Markusen, et al. (1993). They look at exogenous trade costs and environmental policies and show that the latter can have a very strong impact on a firm's decision about location when

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[4] Examples are the Montreal Protocol on substances that deplete the ozone layer, the Convention on Biological Diversity, the Convention on International Trade in Endangered Species, the Basel Convention on the international movement of toxic waste, and the United Nations Framework Convention on Climate Change and its Kyoto Protocol aimed at curbing emissions of greenhouse gas.

[5] WTO ministerial conference in Doha set Jan. 1, 2005 as the deadline for negotiations on clarifying the relationship between WTO rules and the trade obligations established by the MEAs. The fifth WTO ministerial conference in Cancun however did not give much emphasis to green issues and no consensus was reached to produce a new mandate or reaffirm the existing timeframe. (http://www.wto.org/english/thewto_e/minist_e/min03_e/min03_e.htm)

[6] Barrett (1997) shows how committing to trade sanctions in a MEA such as the Montreal Protocol can work as a credible threat to deter free-riding and sustain cooperation. Zigic (2000) further shows how punitive tariffs can be used as a credible threat to improve intellectual property rights regime in the same spirit as they are projected to improve environmental standards in the Doha proposal.

firms are "footloose". Motta and Thisse (1994) consider a different setting where firms are initially established in their country of origin and do not incur any fixed cost when operating at home. They also examine the impact of a country's exogenous environmental policy on the location and production choices of its firm.[7] They show that a firm is less likely to relocate as a response to environmental policies because fixed costs of establishing a domestic plant are sunk when the game begins. Hoel (1997) extends the study to endogenize environmental policy demonstrating that governments have an incentive to choose loose environmental standards to attract firms as long as the disutility from pollution is not high enough to promote a 'Not In My Back Yard' policy. Finally, Ulph and Valentini (2001) show on the contrary that environmental dumping is greater when plants are 'not' footloose as this can create strategic rent-shifting incentives for governments. On the empirical side, studies on the issue have largely rejected any link between firm location and environmental policy. Smarzynska and Wei (2001), Eskeland and Harrison (2003) and Grether and Melo (2003) are a few examples of recent empirical works that find little or no evidence on the pollution haven hypothesis.

This paper endogenizes the decision of firms on location and governments' policies on trade and environment to see whether proposals made at the Doha round can be effectively implemented. It shows that when pollution related costs realistically constitute only a small portion of firms' total cost, tariffs can work in line with Barrett (1997) as a successful credible threat to make environmental harmonization and free trade the unique subgame perfect equilibrium outcome.[8] If a non-signatory country deviates, optimal green tariffs are positive

[7] In their model they also give the multinational firm the choice of closing down home production altogether and establishing a plant abroad to serve both markets. Additionally, they assume the other firm to be a local firm with its location (as well as the other country's policy) as given.

[8] Although we examine all levels of pollution tax in the paper, only very low values reflect reality and are of relevance for the results. A wide range of studies such as Noerdstrom and Vaughan (1999) show that pollution related costs only account for a very small proportion of a firm's total costs. These costs only come up to no more than 1% of production costs for an average industry in the North and at most 5% for the worst polluters. Hence, we emphasize the results for low enough levels of emission tax.

eliminating multinationals' incentives to delocate.[9] Therefore, the so-called escape to pollution havens is not an equilibrium outcome in accordance with recent empirical findings, and all capital movements occur due to other non-pollution related factors.

The Doha proposal is illustrated in the following game: in the first stage, the Southern government chooses whether or not to adopt standards taking into consideration that the North can impose a tariff against its imports in the second stage upon non-compliance. If the South chooses to harmonize its environmental standards, tariffs are abolished to allow for economic integration as a complement or a reward. The governments also anticipate firms' decision on output and location. The Northern firm moves next by choosing location in the third stage and competes in production with the Southern firm in the final stage. The stages of the game are illustrated in figure 1. The rest of the paper is organized as follows: Section 2 describes the model and solves the final two stages of the game when environmental standards are not enforced in the South. Section 3 introduces the other branch of the game where the South ratifies with the MEA and shows the outcome on output and location under harmonized standards. Section 4 finds the optimal tariff set by the North and the optimal environmental policy chosen by the South, and analyzes possible equilibria of the Doha proposal. Section 5 concludes.

2. Asymmetric Environmental Standards

2.1. The Model

There are two countries in the model: the North and the South. The regions are assumed to be symmetric in all aspects aside from their environmental regulations. The North is assumed to enforce environmental standards by imposing a pollution tax on emissions released by firms during production. The South in contrast can choose to adopt standards and enjoy trade liberalization or to keep its lax environmental regulations and pay tariffs.[10] The latter option

[9] Green tariffs refer to trade barriers raised for environmental purposes, i.e. trade obligations in MEAs.

[10] While Southern policy with regards to participating in a MEA is endogenized, the magnitude of the standards required in the MEA remains exogenous in the model.

allows local as well as foreign firms operating in the South to produce without any additional charges for causing pollution. There is however a green tariff in this case set optimally by the North against *all* dirty imports from the South, including re-exports of the Northern firm.[11]

The model assumes two firms with one belonging to each country. They produce a homogeneous good and compete in an oligopolistic manner à la Cournot. Firms compete in segmented markets and choose the optimal output for each market separately. The Northern firm is a multinational and can decide on production location. It can stay at home and serve both markets from its Northern headquarters. It can also build a subsidiary in the South to serve the Southern market, but still maintain production in the North to serve its home interests. Alternatively, it can close down home production altogether and completely delocate for pollution-related purposes to serve both markets from the South. The Southern firm on the other hand is assumed to be a local firm for simplicity and only produces in its domestic country.[12]

Demand is assumed to be linear and takes the familiar form

$$p_i = a - Q_i \qquad for \quad i = N, S \,, \tag{1}$$

where Q is the total consumption in each region, and subscripts N and S represent the North and the South. Total consumption in each region is

$$\begin{aligned} Q_N^E &= q_{SN} + q_{NN} \qquad & Q_S^E &= q_{SS} + q_{NS} \\ Q_N^F &= q_{SN} + q_{NN} \qquad & Q_S^F &= \tilde{q}_{SS} + \tilde{q}_{SS}\,*\,, \\ Q_N^D &= \tilde{q}_{SN} + \tilde{q}_{SN}\,* \qquad & Q_S^D &= \tilde{q}_{SS} + \tilde{q}_{SS}\,* \end{aligned} \tag{2}$$

where the first subscript indicates where the good is produced and the second denotes where it is consumed. Superscript E represents the case where the Northern firm produces only in the North and exports to the South, F when it undertakes FDI to serve the Southern market locally, and D when it completely delocates and re-exports back to the North. The tilde above q denotes a situation where both firms produce in the South, while a star distinguishes

[11] Note that the model only considers goods that are directly related to the environmental problem.

[12] This locational framework follows Motta and Thiesse (1994).

Northern foreign production from local output by the Southern firm. The costs of production are divided between non-pollution related costs c and pollution tax τ paid on emissions that are released from producing one unit of the good.

Looking at the case of non-compliance in the rest of this section, the profit function for the Northern firm when all of its production takes place in the North is

$$\pi_N{}^E = q_{NN}(a - Q_N^E - c - \tau e_0) + q_{NS}(a - Q_S^E - c - \tau e_0)\,, \tag{3a}$$

where e_0 represents the unit emission discharged by each firm. It also denotes the pollution intensity of the industry at hand. This locational scenario implies that the Northern firm must pay a pollution tax on its entire production. When it builds a subsidiary in the South to serve each market locally, it only pays a pollution tax on the goods it produces in the North for the domestic market:

$$\pi_N{}^F = q_{NN}(a - Q_N^F - c - \tau e_0) + \tilde{q}_{SS}{}^*(a - Q_S^F - c) - \Gamma\,. \tag{3b}$$

Γ is the fixed cost of setting up a plant abroad which is independent of output. If the Northern firm completely delocates to serve both markets from the South, it avoids paying pollution taxes altogether, but is bound to pay tariffs on its exports back to the North:

$$\pi_N{}^D = \tilde{q}_{SN}{}^*(a - Q_N^D - c - t) + \tilde{q}_{SS}{}^*(a - Q_S^D - c) - \Gamma\,. \tag{3c}$$

The profit of the Southern firm takes the form

$$\begin{aligned}
\pi_S{}^j &= q_{SN}(a - Q_N^E - c - t) + q_{SS}(a - Q_S^E - c)\\
\pi_S{}^F &= q_{SN}(a - Q_N^F - c - t) + \tilde{q}_{SS}(a - Q_S^F - c)\\
\pi_S{}^D &= \tilde{q}_{SN}(a - Q_N^D - c - t) + \tilde{q}_{SS}(a - Q_S^D - c)
\end{aligned} \tag{4}$$

for each scenario that prevails subsequent to the Northern firm's decision on production location. Recall that there is no environmental tax enforced in the South here, but a tariff is paid on Southern exports to the North.[13] Adopting backward induction, section 2.2 first solves the problem of firms in the final stage where they compete in output.

[13] Tariffs and pollution taxes have been normalized to the market size to allow for the elimination of *(a-c)* from all upcoming equations.

2.2. Production

In the export case, production by the Northern firm in the North for each market is

$$q_{NN} = \frac{1+t-2\tau e_0}{3}, \tag{5}$$

$$q_{NS} = \frac{1-2\tau e_0}{3}, \tag{6}$$

while the Southern firm produces

$$q_{SS} = \frac{1+\tau e_0}{3}, \tag{7}$$

$$q_{SN} = \frac{1-2t+\tau e_0}{3}. \tag{8}$$

$t \geq 2\tau e_0 - 1$ is a constraint for $q_{NN} \geq 0$ to hold so that the Northern firm continues to serve its home market through local production.[14] $t \leq \frac{1+\tau e_0}{2}$ is also a necessary condition for the Southern firm to maintain its exports to the North, i.e. for $q_{SN} \geq 0$. This threshold value of t stops the importation of all dirty products to the North by blocking trade and gives the Northern firm a monopoly position in its home market. Such prohibitive tariff rates denote a complete ban on imports from the South making values of t above this level irrelevant for the analysis. In the case of FDI, q_{NN} and q_{SN} remain similar to (5) and (8) as the Northern firm keeps producing for its home market from a local plant. It however builds a subsidiary in the South to serve the latter locally, making the output aimed at the South

$$\tilde{q}_{SS}^* = \tilde{q}_{SS} = \frac{1}{3} \tag{7'}$$

for both firms. When the Northern firm delocates, production for the Southern market by both firms remains the same as (7'). The Northern firm also produces for its domestic market in the South and re-exports back to the North, making production by both firms aimed at the North

$$\tilde{q}_{SN}^* = \tilde{q}_{SN} = \frac{1-t}{3}. \tag{8'}$$

[14] It will be seen that this constraint is never binding as it coincides with the scenario of complete delocation, where the Northern firm does not produce at home and no longer pays an emission tax.

If the Northern firm produces at home for the domestic market, the direct effect of tariffs is to increase local production in the North and reduce imports from the South. Stricter standards per se have the reverse effect of reducing Northern production and encouraging production by the Southern firm. When the Northern firm exports to the South, τ affects the entire production by both firms, whereas with FDI only goods targeted at the Northern market are influenced. As under FDI both firms produce in the South for the Southern market where no pollution tax exists, the optimal quantity produced by both firms resembles that in a typical Cournot case. Finally, if the Northern firm completely closes down production in the North and establishes a plant in the South to serve both markets, pollution taxes become irrelevant and tariffs reduce the exports of both firms to the North.

2.3. Location

In the third stage of the game, the Northern multinational must choose where to locate to serve each market. By substituting the optimal output back into the Northern firm's profit function and comparing the profits for each case, we can find the locational outcome that yields the most profits. Northern profits for each scenario are simply

$$\pi_N^E = q_{NN}{}^2 + q_{NS}{}^2, \tag{9a}$$

$$\pi_N^F = q_{NN}{}^2 + \tilde{q}_{SS}*^2 - \Gamma, \tag{9b}$$

$$\pi_N^D = \tilde{q}_{SN}*^2 + \tilde{q}_{SS}*^2 - \Gamma. \tag{9c}$$

Looking first at profits of keeping all production in the North against establishing an extra plant in the South, we can see that in the absence of relocation costs Γ, a firm would always be better off by serving each market through a local subsidiary.[15] The critical level of fixed costs that makes $\pi_N^E = \pi_N^F$ is

[15] This also reflects the branch of literature on environment and firms' location pioneered by Markusen et al. (1993) that assumes firms to be footloose. Thus, there are no extra costs for relocation as they incur a plant specific fixed cost regardless of whether they build a plant at home or in the other region. The number of plants would however matter in determining the total fixed costs in this case.

$$\overline{\Gamma} = \frac{4}{9}\tau e_0 (1 - \tau e_0)\,. \tag{10}$$

When fixed costs are below this level, costs of relocation are sufficiently low making FDI the preferable scenario. Otherwise, relocation is too costly and the Northern firm keeps all production at home anyway leaving no concern about the supplementary influence of environmental policies on firm location. This scenario reflects a situation where there is no threat of relocation due to very high plant-specific fixed costs, or inflexible foreign investment laws and political instability in the host country. As we are interested in a case where relocation is at least partly an option, this paper focuses on a situation with sufficiently low fixed costs of relocation. The export scenario where the Northern firm keeps all production in the North is therefore ruled out under asymmetric standards.[16]

We can now concentrate on the comparison between profits under FDI and delocation to distinguish between the standard form of capital movement and relocation due to pollution-related reasons. The threshold tariff rate below which the Northern firm completely delocates is the t that makes profits under the two options equal ($\pi_N^F = \pi_N^D$):

$$\bar{t} = \tau e_0\,. \tag{11}$$

Figure 2 shows the locational choice of the Northern firm in the space of τ and t for an emission level of $e_0=1$. It is easy to see that a higher pollution tax in the North makes delocation to the South more attractive. The shaded area shows the region where tariffs halt trade. $\frac{\partial \bar{t}}{\partial \tau} > 0$ implies that tougher standards require a higher tariff on dirty goods from the South to impede delocation. We can also see that in the case of free trade, profits of completely delocating to the South are always higher than having local facilities in each country. This reinforces the complementary nature of economic integration and environmental standards by showing that without a trade policy, the smallest amount of

[16] The dividing line between the export and the FDI case has been studied in Motta and Thisse (1994). It plays a more important role in their analysis, as they also look at differences in the market size between regions and changes in fixed costs of establishing a plant.

pollution tax could result in complete delocation of multinationals to countries with lax environmental regulations. As tariffs rise, delocation becomes less attractive for a larger range of Northern pollution tax.

3. Environmental Harmonization and Trade Liberalization

This section of the paper analyzes the consequences of policies that suggest global harmonization of environmental regulations. This can be interpreted as a successful implementation of policies discussed at the WTO Doha round, to only allow those WTO members integrate and enjoy trade liberalization who have ratified a MEA and raised their environmental standards to the level in force in signatory countries. Here the South upgrades its standards to the level imposed in the North, namely τ, and enjoys free trade as a reward, i.e. tariff t is abolished.

There is only one possible scenario in the case of harmonized standards as liberalized trade and symmetry in environmental policies make the multinational indifferent about location. There are no incentives for relocation in such situation, and the smallest form of relocation fixed costs causes firms to remain in their home country. Both firms now pay the pollution tax τ on the emissions they release during production, while trade is liberalized. The profit functions of the two firms are now

$$\pi_N^H = q_{iN}(a - Q_N^H - c - \tau e_0) + q_{iS}(a - Q_S^H - c - \tau e_0) \qquad for \quad i = N, S\ , \tag{12}$$

where superscript H stands for harmonized environmental standards. In this case, the quantity produced by each firm for the domestic and the foreign market is identical:

$$q_{NN}{}^H = q_{NS}{}^H = q_{SN}{}^H = q_{SS}{}^H = \frac{1 - \tau e_0}{3}\ . \tag{13}$$

Profits are equal for both firm under harmonized standards and are

$$\pi_i^H = q_{iN}{}^{H^2} + q_{iS}{}^{H^2} \qquad for \quad i = N, S\ . \tag{14}$$

Profits are lower the more stringent are the standards required in the MEA. We now turn to the first two stages of the game where the South decides whether or not to comply with environmental harmonization and the North chooses an optimal punishing tariff in the case of non-compliance. By choosing to adopt standards, the South makes relocation redundant for the Northern firm and forces the latter to keep all production at home. When the South disagrees to adopt standards on the other hand, the Northern firm can decide whether to undertake FDI or completely delocate production using the approach explained in section 2.3.

4. Optimal Policy by Governments

4.1. Welfare

This section introduces the components of welfare for the North and the South under each scenario. Economic welfare in this setting is the sum of consumer surplus and producer surplus minus the disutility caused by pollution, plus the tariff revenue for the North.

Consumer surplus is the area under the demand curve and can be written as half of the total output intended for each region squared:

$$CS_i^{\,j} = \frac{{Q_i^j}^2}{2} \qquad for \quad i = N, S, \quad j = F, D. \tag{15}$$

Consumer surplus in the North and the South when the latter does not adopt standards is

$$\begin{aligned} CS_N^F &= \frac{(2 - t - \tau e_0)^2}{18} \\ CS_S^F &= \frac{2}{9} \end{aligned}, \tag{15a}$$

$$\begin{aligned} CS_N^D &= \frac{2}{9}(1 - t)^2 \\ CS_S^D &= \frac{2}{9} \end{aligned}, \tag{15b}$$

for FDI and delocation respectively. When standards are adopted, consumer surplus turns to

$$CS_i^H = \frac{2}{9}(1 - \tau e_0)^2 \qquad for \quad i = N, S\,. \tag{15c}$$

Producer surplus with no standards in the North is the profits in (9b) and (9c) for FDI and delocation respectively. Producer surplus in the South on the other hand equals Southern profits from (4) using the appropriate output for each case:

$$\pi_S^F = {q_{SN}}^2 + {\tilde{q}_{SS}}^2, \tag{16a}$$

$$\pi_S^D = {\tilde{q}_{SN}}^2 + {\tilde{q}_{SS}}^2\,. \tag{16b}$$

Equation (14) represents producer surplus for both regions with harmonized standards.

The third component of welfare is the disutility caused by pollution in each region. This is parameterized as D_i and contains total emissions in each region and a parameter d_i, which measures the concern of the population of a country about pollution:

$$D_i^j = d_i E_i^j \qquad for \quad i = N, S; \quad j = E, F, D. \tag{17}$$

Another interpretation for parameter d_i is the relative importance of the disutility caused by emissions against the utility gained from the other components of welfare.[17]

Pollution is assumed to be of the transboundary type.[18] Total world pollution depends on whether the non-signatory joins the MEA, the trade obligations of the MEA, and the location of the Northern multinational. Looking at the case with no standards, total world emission is

$$E^F = \frac{1}{3} e_0 (4 - t - \tau e_0)\,, \tag{18a}$$

$$E^D = \frac{2}{3} e_0 (2 - t)\,, \tag{18b}$$

when the multinational has a local subsidiary in each country and when it completely delocates respectively. Under harmonized standards, total emission turns to

$$E^H = \frac{4}{3} e_0 (1 - \tau e_0)\,. \tag{18c}$$

The first order conditions of emissions released with respect to pollution taxes and tariffs show how the environment can be affected through government policies. The derivatives are trivially negative with respect to t and τ implying that green tariffs and emission taxes per se are beneficial for the environment. When delocation is binding ($t < \tau e_0$), pollution is always lower when standards are harmonized. When FDI is the locational outcome on the other hand,

[17] Disutility here increases monotonically with pollution. Other functional forms can be used to describe disutility, but the merits of the results remain the same.

[18] Note that most MEAs deal with transboundary or global issues. If pollution is local, there is no role for a MEA or the WTO.

pollution is lower only in a sub-region where $t<3\tau e_0$. Higher tariffs prior to liberalizations reduce production by so much that pollution is actually lower than the harmonization case.

The important question that needs to be asked here is whether environmental policies can be optimally implemented in isolation or in conjunction with trade obligations through a MEA, taking into consideration their consequences on firm location and output and hence on total welfare. Total welfare for each country can now be summarized to

$$\begin{aligned} W_N{}^j &= \pi_N^j + CS_N^j - D_N^j + T \\ W_S{}^j &= \pi_S^j + CS_S^j - D_S^j \end{aligned} \tag{19}$$

for $j=F,D,H$ using the corresponding values found above for each component of welfare. T is the tariff revenue and equals unit tariff rate t times the total quantity exported to the North.

4.2. Optimal Northern Tariff

The welfare function derived in the previous section can now be used to see if it is optimal for the North to impose a punishing tariff on the South if the latter refuses to adopt the standards required in a MEA. The Northern government sets an optimal tariff that maximizes its welfare in the second stage for each scenario. It then compares Northern welfare for FDI and delocation using the respective optimal tariffs. Taking the decision of its firm on location into consideration, it chooses the optimal tariff that results in a higher Northern welfare.[19]

The optimal tariff for each case can easily be found by differentiating Northern welfare in (19) with respect to t using the appropriate components from the previous sections to get

$$t^{*F} = \frac{1 + d_N e_0}{3}, \tag{20a}$$

$$t^{*D} = d_N e_0, \tag{20b}$$

for FDI and delocation respectively. The optimal tariff is positive for all levels of environmental standards and is increasing with higher pollution concerns in the North. Note from (20b) and (11) that a level of concern $d_N>\tau$ implies a tariff rate of $t^{*D} > \bar{t}$; therefore,

[19] Recall that the tariff is set before the decision of the firm about location; therefore, there are no profit-shifting incentives present in the model.

t^{*D} is only binding for $d_N \leq \tau$ as delocation only occurs in this range. When $d_N > \tau$, the maximum tariff where delocation is still possible, $\bar{t}$, is instead chosen. Given the optimal tariffs, there is a threshold level of pollution tax under which the North prefers a FDI situation to complete delocation in terms of welfare. This is the τ, which makes welfare under FDI and delocation equal given the corresponding optimal tariffs:

$$\hat{\tau} = \begin{cases} \dfrac{2 - d_N e_0 - \sqrt{3[1 - 2d_N e_0(1 - d_N e_0)]}}{3e_0} & \text{for} \quad d_N \leq \tau \\[2ex] \dfrac{2 + d_N e_0 - \dfrac{\sqrt{21 + 6d_N e_0(1 - d_N e_0)}}{3}}{5e_0} & \text{for} \quad d_N > \tau. \end{cases} \tag{21}$$

When unit emission is set to unity, this critical value of τ starts with 0.1 for $d_N=0$ and is continuously increasing in d_N at a slow rate.[20] Unless standards required in a MEA are unrealistically high, the Northern government prefers a FDI situation to delocation for all levels of d_N when optimal tariffs are in place. This makes t^{*F} the relevant tariff for this region. A higher concern over pollution in the North simply increases the optimal tariff and the range of environmental tax where the North prefers FDI to delocation.

The Northern optimal tariff is illustrated in figure 3 for $d_N=0$ along the applicable range of τ. The effects of changes in d_N on t^{*F} and $\hat{\tau}$ are also demonstrated in the figure. The thick line illustrates the optimal tariff used, which is t^{*F} for the range of τ where FDI is preferable to delocation ($0 \leq \tau \leq \hat{\tau}$) and min $\{\bar{t}, t^{*D}\}$ thereafter. The optimal level of tariffs results in a FDI scenario in the region of interest implying that FDI for motives other than pollution is the only form of capital movement to the South. Even upon non-compliance by the South, delocation to pollution havens does not occur due to positive optimal tariffs, reinforcing empirical studies that have found weak or no evidence for the pollution haven hypothesis. Delocation is a purely theoretical outcome that only arises in the non-realistic case where pollution related costs amount to a very high fraction of total costs. This suggests an explanation for why

[20] The qualitative results remain the same for other pollution intensities as all results adjust proportionally for different values of e_0.

concerns over pollution havens are restricted to theory and not consistent with empirical evidence.

Proposition 1

A positive optimal Northern tariff makes FDI the equilibrium locational outcome if the South deviates and does not ratify. Pollution-related delocation hence does not take place in a plausible range of τ, discrediting the pollution haven hypothesis also in theory.

Taking the MEA trade obligations into consideration, the Southern government moves in the first stage to commit to its optimal environmental policy.

4.3. Optimal Southern Environmental Policy

We turn to the first stage of the game to analyze the Southern government's policy choice, namely whether to adopt standards and enjoy trade liberalization or to continue to ignore MEAs and pay punishing green tariffs. Looking at the Southern welfare function from (19) after substituting for its components from the appropriate equations, it is easy to demonstrate if adopting standards would be beneficial for the South. Comparing (15a) and (15b) with (15c), we can see that Southern consumer surplus is always lower when environmental standards are harmonized. Southern producer surplus also falls with the adoption of standards if delocation prevails under no standards ($t<\tau e_0$). If FDI is the prospective non-compliance outcome on the other hand, there is a threshold tax level $\tilde{\tau} < \dfrac{3-2t \pm \sqrt{8t^2-16t+9}}{e_0}$ under which the Southern firm is better off when standards are harmonized in the two regions. This is due to tariff savings that arise from move to free trade. Yet, this advantage is only materialized for low values of τ, where switching policy results in higher total production by the Southern firm. Furthermore, $\pi_S^D > \pi_S^F$ for $t>\tau e_0$ implies that the interests of the Southern firm are always in conflict with the Northern firm's preferences on location.

In the rest of this section, we focus on the case where there is no concern over pollution in the South ($d_S=0$).[21] In a delocation scenario, the South never finds it optimal to ratify as it is

[21] While this makes the notation much easier to follow, all results hold for positive values of d_S.

strictly better off with no standards. When FDI is the locational outcome under no standards on the other hand, there is a critical level of τ below which ratification is desired by the South. This level of pollution tax solves for $W_S^F = W_S^H$ and is

$$\bar{\tau} = \frac{5 - 2t \pm \sqrt{16t^2 - 32t + 25}}{3e_0}\ . \tag{22}$$

The hyperbola in figure 3 shows the locus where Southern welfare with ratification is equal to that of the FDI / no standards case. The area to the left of the curve is the region where the South is better off by adopting standards. Gains from producer surplus and tariff revenues outweigh consumer surplus losses in this region. Anticipating Northern optimal tariffs from the second stage t^{*F}, the South ratifies the MEA as the tariff makes the Southern policy choice fall right in the region where compliance is optimal. This makes harmonization the unique equilibrium outcome for the relevant range of τ. Here tariffs work successfully as a credible threat to motivate environmental harmonization without actually being put into practice. The Doha proposal can hence be deemed effective for fairly low values of τ consistent with data, and is a subgame perfect equilibrium outcome. Only in the unlikely case of a very high τ, standards would not be adopted and the equilibrium outcome turns to delocation.

Proposition 2

Trade obligations, i.e. green tariffs, work as a credible threat to persuade the South to ratify a MEA that requires an upgrading of its standards. The Doha proposal is hence effective as environmental harmonization with trade liberalization is the unique subgame perfect equilibrium outcome for a modest range of τ.

5. Conclusion

This paper studies the importance of MEA trade obligations for a successful round of international environmental negotiations. It particularly emphasizes on the proposal made at the Doha round of the WTO with regards to the introduction of conditional consent for economic integration upon ratification of certain MEAs. Non-cooperation in this case allows for punishing tariffs against a country with environmental standards weaker than those set out in the MEA. Building a framework to reflect the Doha proposal, the paper shows that for a modest range of requirements, it is optimal for a non-signatory country to upgrade its standards according to the MEA. Trade obligations in the MEA work *only* as a credible threat to deter delocation and motivate environmental harmonization. Even if the Southern government deviates, Northern optimal tariffs are positive so pollution motivated delocation never occurs.

It was found in the light of Carraro and Siniscalco (1994) that unlike conventional environmental policy recommendations, a policy to control pollution can only be optimal when it is a mix of complementary measures. Since a pollution tax alone may not be an effective policy tool, its role must be reassessed and trade obligations must be considered when reaching out for environmental targets. If green tariffs can serve as a successful threat against delocation and eco-dumping policies, they may at times be the only means of a move towards more successful international environmental negotiations. Yet, the paper shows that positive tariffs do not turn up in equilibrium.

The model in the paper is only a cornerstone to highlight the basic roles of green tariffs and the potential need for trade obligations to achieve the outcomes desired in a MEA. It can easily be extended to investigate an optimal emission tax rate for each region, or one to study whether a world optimal tariff through an international body can be used to induce participation in a MEA when the latter is globally optimal. It is interesting to study the effects of such tariffs and/or emission tax on the R&D effort by firms to abate pollution. It is also important to look into more direct measures of improving the environment such as abatement R&D subsidies to avoid creating a distortion. It must however be taken into account that such subsidies must be financed from costly taxation. Extending the model to include more countries is a next step to see the impact of the number of signatories on the decision of a non-signatory in regards to ratification. Another interesting line of research is to study the issue into a multi-firm, multi-sector general equilibrium framework.

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Figure 1: R&D investment by the Northern Firm

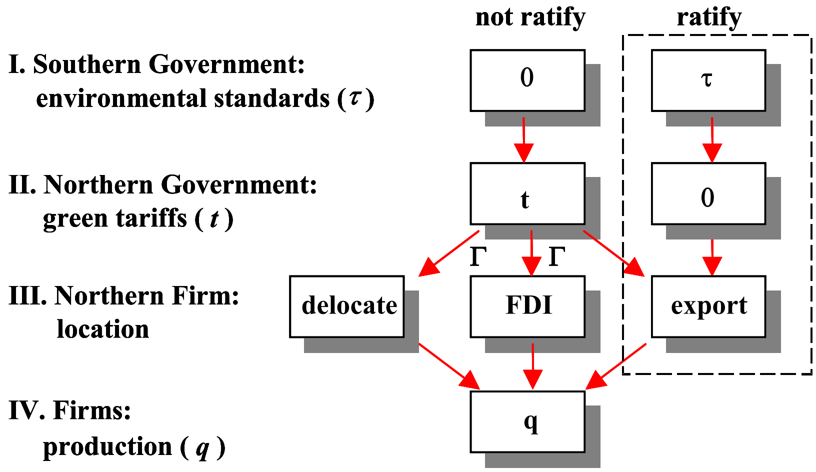


Figure 2: Location of the Northern Firm

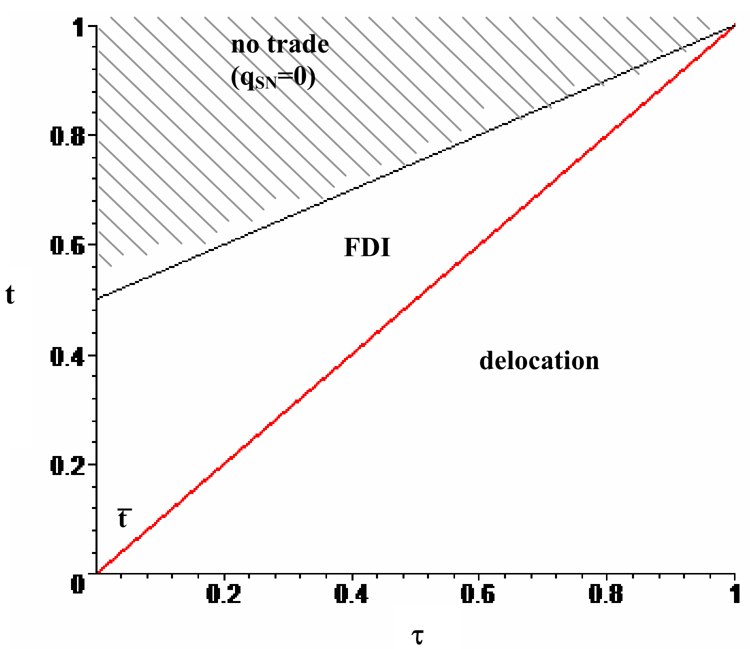
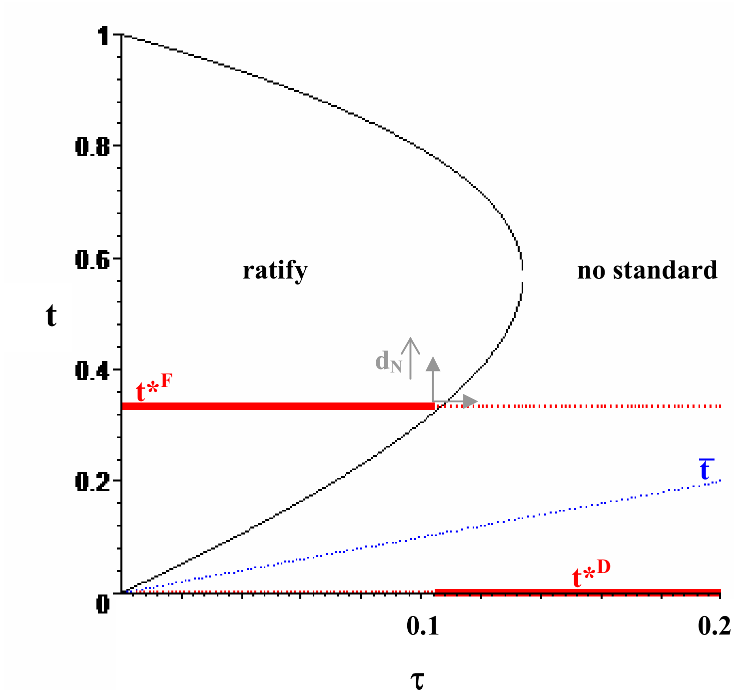


Figure 3: Optimal Government Policies



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(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003
(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003
(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003
(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003
(lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003
(lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004
(lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004
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